WHAT IS CLAIMED IS:

1. An optical device comprising:

a first optical member separating an incident light of wavelength λ into a TE wave and a TM wave; and

an optical input portion, which inputs the incident light into the first optical member;

wherein the first optical member has a periodically changing refractive index;

wherein an angle defined by a first reciprocal lattice vector α_1 and a second reciprocal lattice vector α_2 of the first optical member at the wavelength λ is not larger than 90°;

wherein, in the direction of the first reciprocal lattice vector α_1, the wave number of the TE wave is larger than the wave number of the TM wave;

wherein, in the direction of the second reciprocal lattice vector α_2, the wave number of the TE wave is smaller than the wave number of the TM wave; and

wherein the optical input portion inputs the incident light in a direction that is parallel to a plane P_{12} including the first reciprocal lattice vector α_1 and the second reciprocal lattice vector α_2.

2. The optical device according to claim 1, wherein the first optical member has a structure in which a plurality of materials of different refractive indices are arranged with a constant period in a two-dimensional direction.

3. The optical device according to claim 1,

wherein the first optical member includes a first material and a plurality of particles disposed inside the first material;

wherein the particles are made of a second material that has a different refractive index from the first material; and

wherein the particles are disposed with a constant period inside the first material.

4. The optical device according to claim 1,

wherein the first optical member includes a first material and a

plurality of columnar portions disposed inside the first material;

wherein the plurality of columnar portions are made of a second material that has a different refractive index from the first material;

wherein the center axes of the columnar portions are parallel to one another and perpendicular to the incidence direction of the incident light; and

wherein the plurality of columnar portions are arranged with a constant period.

5. The optical device according to claim 1,

wherein the first optical member includes a plurality of first layers and a plurality of second layers that are layered in alternation in the incidence direction of the incident light; and

wherein the first layers are made of a first material, and the second layers are made of a second material that has a different refractive index from the first material.

6. The optical device according to claim 1,

further comprising an optical output portion receiving light that is emitted from the first optical member;

wherein the optical input portion comprises an optical fiber F(0);

wherein the optical output portion comprises optical fibers F(1) and F(2);

wherein the optical fibers F(0) and the optical fibers F(1) and F(2) are arranged parallel to the plane P_{12}; and

wherein the TE wave that is emitted from the first optical member is incident on an end portion of the optical fiber F(1) and the TM wave that is emitted from the first optical member is incident on an end portion of the optical fiber F(2).

7. The optical device according to claim 1,

further including a second optical member;

wherein the first optical member and the second optical member are arranged such that light that entered from the optical input portion is transmitted first through the first optical member and then through the second optical member;

wherein the second optical member has a periodically changing

refractive index;

wherein an angle defined by a first reciprocal lattice vector β_1 and a second reciprocal lattice vector β_2 of the second optical member at the wavelength λ is not larger than 90°;

wherein, in the direction of the first reciprocal lattice vector β_1, the wave number of TE waves is larger than the wave number of TM waves;

wherein, in the direction of the second reciprocal lattice vector β_2, the wave number of TE waves is smaller than the wave number of TM waves; and

wherein a plane including the first reciprocal lattice vector α_1, the second reciprocal lattice vector α_2 and the optical axis of incident light and a plane including the first reciprocal lattice vector β_1, the second reciprocal lattice vector β_2 and the optical axis define an angle of 45° around the optical axis.

8. The optical device according to claim 7, wherein the second optical member has the same structure as the first optical member.

9. The optical device according to claim 7,

further comprising an optical output portion receiving light that is emitted from the second optical member;

wherein the emitted light includes a first and a second TM wave and a first and a second TE wave;

wherein the optical input portion comprises an optical fiber F(0);

wherein the optical output portion comprises optical fibers F(1), F(2), F(3) and F(4);

wherein the optical fiber F(0) and the optical fibers F(1), F(2), F(3) and F(4) are arranged parallel to the plane P_{12}; and

wherein the first TM wave is incident on an end portion of the optical fiber F(1), the second TM wave is incident on an end portion of the optical fiber F(2), the first TE wave is incident on an end portion of the optical fiber F(3), and the second TE wave is incident on an end portion of the optical fiber F(4).

10. The optical device according to claim 1,

further including second to n-th optical members (wherein n is an integer of 3 or larger);

wherein the k-th optical member (wherein k is an integer between 2 and n) is arranged such that it receives light inputted from the optical input portion and outputted from the (k – 1)-th optical member;

wherein the second to n-th optical members have a periodically changing refractive index;

wherein an angle defined by a first reciprocal lattice vector k_1 and a second reciprocal lattice vector k_2 of the k-th optical member at the wavelength λ is not larger than 90°;

wherein, in the direction of the first reciprocal lattice vector k_1, the wave number of TE waves is larger than the wave number of TM waves; and

wherein, in the direction of the second reciprocal lattice vector k_2, the wave number of TE waves is smaller than the wave number of TM waves.

11. The optical device according to claim 10, wherein the second to n-th optical members have the same structure as the first optical member.

12. The optical device according to claim 10, wherein, when plane k_{12} is the plane including the first reciprocal lattice vector k_1, the second reciprocal lattice vector k_2 and the optical axis of the incident light, and plane $(k-1)_{12}$ is the plane including the first reciprocal lattice vector $(k-1)_1$ of the (k – 1)-th optical member, the second reciprocal lattice vector $(k-1)_2$ of the (k – 1)-th optical member and the optical axis, then the plane k_{12} and the plane $(k-1)_{12}$ define an angle of 45° around the optical axis.

13. The optical device according to claim 12,

further comprising 2^n outgoing optical fibers receiving light that is emitted from the n optical members;

wherein the emitted light includes first to (2^{n-1})-th TE waves and first to (2^{n-1})-th TM waves;

wherein the optical input portion comprises an optical fiber F(0);

wherein the optical fiber F(0) and the 2^n outgoing optical fibers are arranged parallel to the plane P_{12}; and

wherein the first to (2^{n-1})-th TE waves and the first to (2^{n-1})-th TM waves are incident on end portions of different outgoing optical fibers.

14. The optical device according to claim 10,

further comprising a Faraday crystal, an outgoing optical fiber F(1),

and a magnetic field generator for applying a magnetic field that saturates the rotation angle of the Faraday crystal;

wherein said n is 3, so that the optical device includes second and third optical members;

wherein the first optical member, the Faraday crystal, the second optical member, the third optical member and the optical fiber F(1) are arranged such that light that enters from the optical input portion is transmitted in that order;

wherein the angle defined by first reciprocal lattice vector α_1 and the first reciprocal lattice vector of the second optical member is 45°;

wherein the angle defined by the first reciprocal lattice vector of the second optical member and the first reciprocal lattice vector of the third optical member is 90°.

15. The optical device according to claim 1,

further comprising a Faraday crystal, a polarization-rotating crystal, a second optical member, an outgoing optical fiber F(1), and a magnetic field generator for applying a magnetic field that saturates the rotation angle of the Faraday crystal;

wherein the first optical member, the Faraday crystal, the polarization-rotating crystal, the second optical member and the optical fiber F(1) are arranged such that light that enters from the optical input portion is transmitted in that order;

wherein the second optical member has a periodically changing refractive index;

wherein an angle defined by a first reciprocal lattice vector β_1 and a second reciprocal lattice vector β_2 of the second optical member at the wavelength λ is not larger than 90°;

wherein, in the direction of the first reciprocal lattice vector β_1, the wave number of the TE wave is larger than the wave number of the TM wave;

wherein, in the direction of the second reciprocal lattice vector β_2, the wave number of the TE wave is smaller than the wave number of the TM wave; and

wherein the first reciprocal lattice vector α_1 and the first reciprocal lattice vector β_1 are parallel.

16. The optical device according to claim 1,

further comprising a phase retarder and an optical output portion;

wherein the first optical member, the phase retarder and the optical output portion are arranged such that light that enters from the optical input portion is transmitted in that order;

wherein the optical input portion inputs p light beams (wherein p is an integer greater than 1), whose wavelengths range from a wavelength $\lambda(1)$ equal to λ and increase at constant wavelength intervals to a wavelength $\lambda(p)$, in a direction that is parallel to the plane P_{12}; and

wherein the phase retarder imparts a difference in polarization between light beams of odd-numbered wavelengths and light beams of even-numbered wavelengths.

17. The optical device according to claim 16,

wherein the phase retarder has a periodically changing refractive index;

wherein, when x is the difference between the wave number of the first reciprocal lattice vector and the wave number of the second reciprocal lattice vector of the phase retarder at the odd-numbered wavelengths, and y is the difference between the wave number of the first reciprocal lattice vector and the wave number of the second reciprocal lattice vector at the even-numbered wavelengths, then the difference between x and y is constant; and

wherein the plane P_{12} and the plane including the first reciprocal lattice vector and the second reciprocal lattice vector of the phase retarder define an angle of 45°.

18. The optical device according to claim 16,

further comprising a second optical member having the same dispersion surface as the first optical member, and a multiplexing portion;

wherein the first optical member, the phase retarder, the second optical member, the multiplexing portion, and the optical output portion are arranged such that light entering from the optical input portion is transmitted in that order;

wherein the phase retarder imparts a phase change, such that light of odd-numbered wavelengths and light of even-numbered wavelengths become linearly polarized perpendicularly to one another;

wherein the first and the second reciprocal lattice vector of the second optical member are parallel to the first and the second reciprocal lattice vectors α_1 and α_2, respectively;

wherein the multiplexing portion multiplexes TE waves and TM waves of either odd-numbered wavelength light or of even-numbered wavelength light;

wherein the optical input portion comprises an optical fiber F(0);

wherein the optical output portion includes an optical fiber F(1) into which light of odd-numbered wavelengths is input, and an optical fiber F(2) into which light of even-numbered wavelengths is input; and

wherein the optical fiber F(0), the optical fiber F(1) and the optical fiber F(2) are arranged parallel to the plane P_{12}.

19. The optical device according to claim 16,

further comprising a second optical member having the same dispersion surface as the first optical member, and a multiplexing portion;

wherein the first optical member, the phase retarder, the second optical member, the multiplexing portion, and the optical output portion are arranged such that light entering from the optical input portion is transmitted in that order;

wherein the phase retarder imparts a phase change, such that light of odd-numbered wavelengths and light of even-numbered wavelengths become linearly polarized perpendicularly to one another;

wherein the angle defined by the first reciprocal lattice vector of the second optical member and the first reciprocal lattice vector α_1 is the same as the angle defined by the first reciprocal lattice vector α_1 and the second reciprocal lattice vector α_2;

wherein the multiplexing portion multiplexes TE waves and TM waves of either odd-numbered wavelength light or of even-numbered wavelength light;

wherein the optical input portion comprises an optical fiber F(0);

wherein the optical output portion includes an optical fiber F(1) into which light of odd-numbered wavelengths is input, and an optical fiber F(2) into which light of even-numbered wavelengths is input; and

wherein the optical fiber F(0), the optical fiber F(1) and the optical fiber F(2) are arranged parallel to the plane P_{12}.

20. The optical device according to claim 1, further comprising an optical output portion for receiving light that is emitted from the first optical member; wherein the optical input portion comprises an optical fiber; wherein the optical output portion comprises an optical fiber for receiving either the TE waves or the TM waves that are emitted from the first optical member.

21. The optical device according to claim 1, further comprising a Faraday crystal, a second optical member having a dispersion surface that is the same as that of the first optical member, an optical output portion, and a magnetic field generator for applying a magnetic field that saturates the rotation angle of the Faraday crystal; wherein the first optical member, the Faraday crystal, the second optical member, and the optical output portion are arranged such that light entering from the optical input portion is transmitted in that order; wherein the plane including the first reciprocal lattice vector α_1, the second reciprocal lattice vector α_2 and the optical axis of the incident light and the plane including the first reciprocal lattice vector β_1 and the second reciprocal lattice vector β_2 of the second optical member and the optical axis define an angle of 45° around the optical axis; wherein the angle defined by the first reciprocal lattice vector α_1 and the first reciprocal lattice vector β_1 is the same as the angle defined by the first reciprocal lattice vector α_1 and the second reciprocal lattice vector α_2; and wherein the optical output portion comprises an optical fiber receiving only either the TE waves or the TM waves emitted by the second optical member.

22. The optical device according to claim 1, further comprising a Faraday crystal, a second optical member having a dispersion surface that is the same as that of the first optical member, an optical output portion, and a magnetic field generator for applying a magnetic field that saturates the rotation angle of the Faraday crystal; wherein the first optical member, the Faraday crystal, the second

optical member, and the optical output portion are arranged such that light entering from the optical input portion is transmitted in that order;

wherein the plane including the first reciprocal lattice vector α_1, the second reciprocal lattice vector α_2 and the optical axis of the incident light and the plane including the first reciprocal lattice vector β_1 and the second reciprocal lattice vector β_2 of the second optical member and the optical axis define an angle of 45° around the optical axis;

wherein the first reciprocal lattice vector α_1 and the first reciprocal lattice vector β_1 are parallel; and

wherein the optical output portion comprises an optical fiber receiving only either the TE waves or the TM waves emitted by the second optical member.